THE NATIONAL PHYSICAL LABORATORY DURING 1908.

THE annual meeting of the general board of the National Physical Laboratory was held at Teddington on the afternoon of Friday, March 19, when the report of the executive committee for the year 1908 was formally presented, and the various departments of the laboratory were thrown open for inspection. The fifth volume of the "Collected Researches," which is now ready for issue, was also laid before the general board, and includes the results of the more important investigations recently carried out at the laboratory.

In connection with this year's gathering, the absence of Lord Rayleigh from the meeting cannot be allowed to pass without remark. Lord Rayleigh has always taken the warmest interest in the development of the laboratory; he has been from the first, and is still, chairman of the executive committee, though during his temporary absence abroad his duties have been undertaken by Sir John Wolfe-Barry, and this is the first occasion on which he has been prevented from being present at the annual inspection. His absence was deplored by none more than the staff, by whom his appreciation and his ready counsel on innumerable matters of detail are especially valued. Sir Archibald Geikie, as president of the Royal Society, acted this year as chairman of the general board.

The report of the executive committee gives some particulars as to the expenditure during 1905–8 on new buildings. These comprise buildings for electrotechnics, including photometry, for metrology, and for metallurgical chemistry, as well as an extension of the engineering building. They have been erected at a cost of about 25,000*l*., and an additional 8000*l*. has been spent on equipment. This latter amount, however, does not include what has been provided out of annual income, nor the many gifts of apparatus. Of the total thus expended, 25,000*l*. has been provided by the Treasury. The grants promised by the Treasury for building purposes have, however, now come to an end; no new buildings have been added during 1908, the funds available being devoted to equipment, which is still by no means complete.

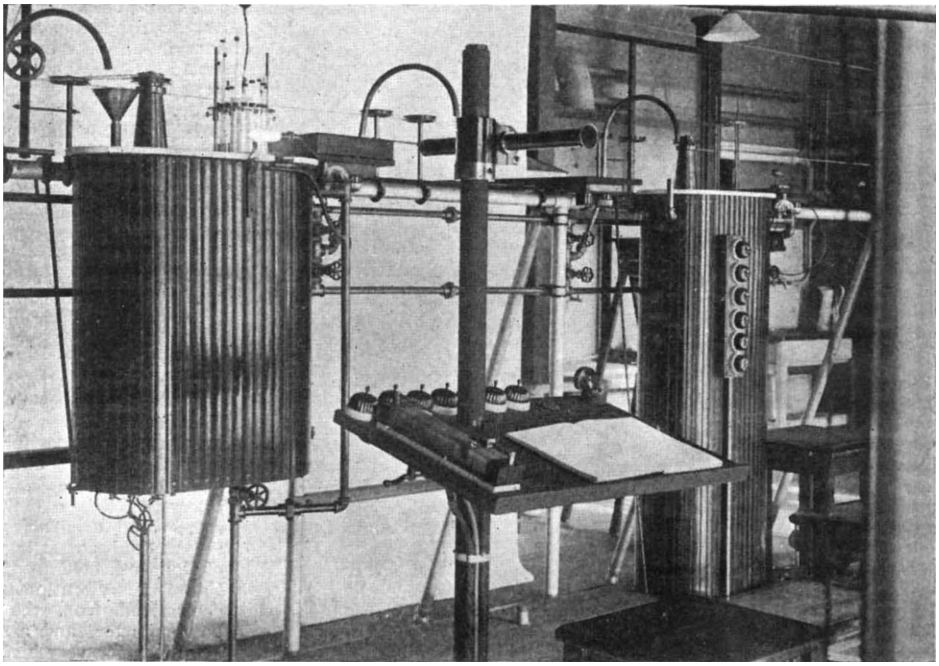

Fig. 1.—Comparison Baths for Verification of Ordinary and Standard Thermometers.

There is thus, unless funds are provided from other sources, no immediate prospect of any considerable extension of existing departments, though the rapid development of the work has shown clearly that the need of further accommodation must shortly become urgent. The department of metallurgy, which is doing work of the greatest value in connection with the most important of British industries, is at present quite inadequately housed in the old kitchen and a few scattered rooms in the basement of Bushy House. Plans have already been prepared for a new building, which would be an extension of that devoted to the Indian railway test-work, but the committee is unable at present to do more than commend the importance of such a department to the attention and generosity of those to whom metallurgical research is of interest and value.

The only development of first-rate importance immediately in prospect is thus the experimental tank for investigations on ship models, building operations for which will be commenced in the spring. The construction of the tank has been rendered possible by the munificence of Mr. A. F. Yarrow, who has placed 20,000*l*. at the disposal of the Institution of Naval Architects for the erection at the laboratory of a tank of the most modern type, under the proviso that a sufficient sum be found to provide for maintenance during the first ten years. The guarantee fund has now reached a total sufficient to warrant the work being begun, and another department of great public interest and utility will thus be added to the laboratory.

Turning now to the details of the work carried out during the year by the several departments, reference may first be made to the re-organisation of the thermometry division of the physics department. Arrangements have been made for transferring to Teddington some of the thermometer testing at present undertaken by the observatory department, and at the same time it has been found necessary to provide increased facilities for the rapid and accurate verification of high- and low-range thermometers, as well as of standards and thermometers of special types. For this purpose the old chemical laboratory, vacated by the transfer of the chemical work to the new building for metallurgical chemistry, has been re-fitted with a new and special equipment for the testing of mercury thermometers, designed by Dr. Harker and Mr. W. A. Price, a description of which is given as an appendix to the report. The chief requisites in connection with baths for thermometer comparisons are efficient stirring, convenient and rapid heating, and satisfactory temperature regulation, with arrangements for avoidance of emergent stem errors. At the same time, suitable provision must be made for the rapid recording of observations. The type of bath and the general arrangements adopted are shown in Fig. 1. The containing vessel of the apparatus consists of two flat boxes of cast brass, the larger containing the thermometers to be tested, while the smaller is occupied by the stirrer above and the electric heating appliances below. The stirrers in all the baths are driven with endless cord and pulleys from an electric motor. The heating is effected by means of special resistance units, each of 400 watts capacity, constructed of "Eureka" strip. The baths are well lagged, and the temperature can be run up very quickly to any desired point. A desk is provided for the observer, above which is the telescope for taking the readings, while a series of switches allows of temperature regulation. By means of a handle on the left of the desk, connected by a flexible shaft to the cage carrying the thermometers, the cage can be rotated so as to bring the thermometers successively into the field of view.

The bath on the right in the illustration is reserved for the comparison of standards. It is of the same general type as above described, but is being fitted with a telescope carried on a traversing support fixed to the bath itself, giving greater rigidity, and thus allowing the employment of a higher magnification. In addition there are a bath for very long thermometers, oil and nitrate baths for the higher temperatures, zero-point apparatus for ordinary and standard thermometers, and steam-point apparatus. The steam-point apparatus for standard thermometers is of the form designed by Chappuis, and is shown in Fig. 2. The upper part can be turned into a horizontal position, so that observations can be made with the thermometer either horizontal or vertical, as required for determination of pressure coefficients. A second steam bath of similar form, but not arranged to tilt, serves for ordinary work.

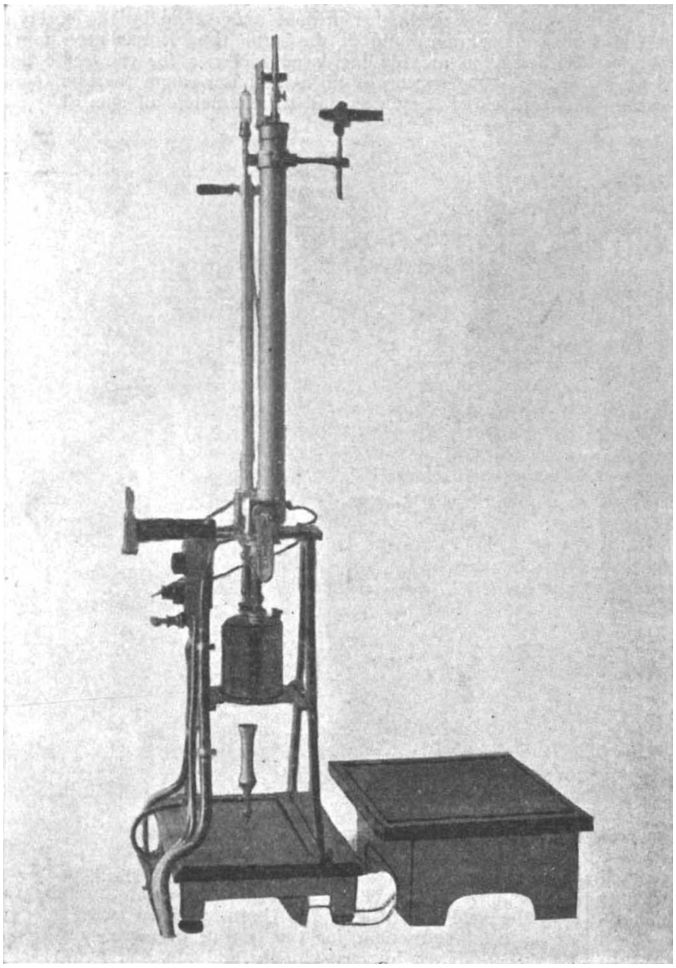

Fig. 2.—Steam Point Apparatus for Standard Thermometers.

The work of the thermometry division has also included the equipment, for work at very high temperatures, of the new electric furnace room. Much attention has been given to the perfecting of furnaces, and some interesting figures are printed in the report showing the increased efficiency obtained in the ordinary platinum-foil wound type with improved construction and lagging. The power required to maintain a temperature of 1350° C. has been reduced from 3300 watts to 1400 watts, the new furnace being at the same time of greater internal capacity than the old. A new type of spiral carbon-tube furnace has been devised, of which a description will be published shortly, and much preliminary work has been done with a view to the greatly needed investigations into the different methods employed in measuring temperatures up to 2000° C.

The chief item of research work completed during 1908 was an investigation, in which Mr. F. P. Sexton assisted, into the effect of pressure on the boiling point of sulphur.

In the electrical standards division much time was spent in intercomparison of standards with those of other laboratories, and the excellent work accomplished by Mr. F. E. Smith was of great value in connection with the International Conference on Electrical Units, held in London in October. The papers published during 1908 include an account of the secular variations in the laboratory standards of resistance, and of the effect on manganin resistances of atmospheric humidity. Vol. v. of the "Collected Researches" contains also a paper describing an improved procedure for setting up mercury standards of resistance. In addition to this work, good progress has been made in the construction of the Lorenz apparatus for the determination of the ohm in absolute measure, which is being presented to the laboratory by the Drapers' Company in memory of the late Prof. Viriamu Jones.

Mr. Campbell has continued his work on self- and mutual-inductance standards. Of special interest is the method he has devised for the direct comparison of a mutual inductance and a resistance, from which may be made a determination of the ohm in absolute measure. A preliminary account of the method has been published in the Proceedings of the Royal Society, and it seems possible that in the further experiments to be made a high degree of accuracy in the absolute determination may be attained. Valuable work has also been done in setting up standards for the determination of oscillation frequencies in wave telegraphy.

From the optics department, a paper by Mr. Hunter describing an apparatus for determining the intensity curve for the image of an "edge" formed by an optical system was recently read before the Royal Society. Of general interest also is a new apparatus for testing the speeds and efficiencies of photographic shutters, the method consisting in photographing a spot of light reflected from the mirror of one of Mr. Campbell's vibration galvanometers. The time is determined from the known frequency of the galvanometer, and a satisfactory trace is obtainable even for very high shutter speeds, which can thus be determined with considerable accuracy. Work which has been in progress for some time on the standardisation of oculists' cases of trial lenses was completed during the year, and the testing and certifying of such trial cases is now regularly undertaken by the laboratory. The testing of microscope objectives is also under consideration.

In the electrotechnics building the chief addition to the equipment is a 100,000-volt transformer by the Westinghouse Co., which was recently installed, and is now working satisfactorily. This will be employed in the continuation of a research on insulating materials, while an investigation into the dielectric strength of ebonite of various compositions is already in progress. A large amount of test work on alternating-current instruments was dealt with during the year, and the equipment for such work has been greatly improved. A new electrostatic wattmeter, constructed in the laboratory workshop, deserves special mention, as well as a series of manganin water-cooled tube resistances with a device for bringing the voltage drop at their terminals into phase with the current passing through them.

In the photometry section, also, good progress has been made, especially in the arrangements for life tests on glow lamps. Life-test frames, designed for dealing with large numbers of lamps, have been constructed in the laboratory; the racks can be tilted, so that the lamps may be burnt at any angle, and resistances are provided for each lamp to bring the voltage on the terminals to the value at which the lamp will run initially at the standard watts per candle. A new specially designed photometer bench, by Alex. Wright and Co., is employed for rapid candle-power measurements of lamps under life test.

Following upon a suggestion made by Dr. Glazebrook at the British Association meeting in Dublin, agreement has been arrived at with the standardising laboratories of some other countries in regard to the adoption of an international light unit, and it is hoped that from an early date it may be possible to express light measurements in terms of the international candle. The matter is engaging the attention of the International Electrotechnical Commission.

The metrology division has been much occupied during the year in transferring apparatus to the new building completed in 1907. A special feature of the building is the long gallery, in which 50-metre surveying tapes can be verified, whether on the flat or in catenary. Special apparatus for the measurements has been constructed by the Cambridge Scientific Instrument Co., and the installation is now nearly complete.

One of the rooms in the metrology building will be devoted to the apparatus for ruling diffraction gratings which belonged to the late Lord Blythswood, and which has been placed on loan at the laboratory by Lady Blythswood. After some alterations which were contemplated by Lord Blythswood, the apparatus will be capable of ruling gratings up to a length of 8 inches.

As in previous years, the division has undertaken a considerable amount of work in connection with the Engineering Standards Committee, and in particular diring 1908 important work has been done on the measurement of screws and screw gauges.

In the engineering department Dr. Stanton is still continuing his very valuable and interesting researches with regard to wind pressure. His paper relating to the wind pressure on structures in the open, and discussing the difference in the resultant pressure on large and small plates, is included in vol. v. of the "Collected Researches." The question considered during 1908 has been the possibility of inferring the maximum pressure on a large area during a gale from the maximum pressure registered at a single point of the area. The attempt to measure the mean pressure over a large area of 1000 square feet was made by means of pressure tubes distributed over the area, and some interesting theoretical results were obtained when a self-recording apparatus was set up to register the mean pressure from more than two such tubes. At present continuous records are being taken of the mean pressure at two points 40 feet apart, and will no doubt furnish information of value. Dr. Stanton has also been investigating the resistance of plates and models in a uniform current of water. Some of the results obtained are included in a communication to be made to the Institution of Naval Architects. A research on the heat transmission and resistance of air currents in pipes is also in progress.

The important work on the behaviour of materials under repeated stresses has been very considerably advanced. An ingenious machine has been devised to make a combined abrasion and bending test under conditions approximating to those of a steel rail in practice; the conditions may be varied from pure abrasion to pure bending. A paper on the resistance of materials to impact was read before the Institution of Mechanical Engineers, and Mr. Bairstow has completed a research on the elastic limits of material under alternating stress.

The work on superheated steam has been continued, and in connection with this a research has been carried out on the loss of heat from steam-pipe flanges.

In both branches of the work of the department of metallurgy and metallurgical chemistry material progress has been made. A paper on cooling curves was read by Mr. Rosenhain before the Physical Society; a paper entitled "Eutectic Research, No. 1, the Alloys of Lead and Tin," was presented to the Royal Society and printed in the Philosophical Transactions, and the research on the copper-aluminium-manganese alloys for the Alloys Research Committee of the Institution of Mechanical Engineers was carried on continuously throughout the year. A report on the first section of this work will shortly be communicated to the institution. In addition, a considerable number of important cases of failure were investigated in cooperation with the engineering department, and some account of this work was given in a paper on the study of breakages, read before Section G of the British Association at Dublin.

In the section of this department devoted to metallurgical chemistry, special attention has been given to the improvement of the equipment and to the organisation of the work. The methods of steel analysis and the apparatus employed were described in a paper read by Mr. Rosenhain before the Iron and Steel Institute, which is reprinted as an appendix to the laboratory report. Of special interest are the silica-tube combustion furnaces for the estimation of carbon, a new type of electric muffle furnace, and the apparatus for electrolytic deposition. New methods of analysis have been investigated, and an improved procedure for the estimation of phosphorus, especially in phosphor-tin, has been described by Messrs. Gemmell and Archbutt.

The work done at the observatory department under Dr. Chree, and the allied work at Eskdalemuir under Mr. Walker, are of special character, and cannot properly be dealt with here. Dr. Chree has completed a monumental piece of work in the reduction and analysis of the magnetic records obtained by the *Discovery* Antarctic Expedition, while in addition he has discussed the magnetic observations of the *Scotia* and the temperature and pendulum observations of the *Discovery*. His work on the Kew records has been continued in a paper, "Magnetic Declination at Kew Observatory, 1890 to 1900," Phil. Trans., A, vol. ccviii., 1908, reprinted in vol. v. of the "Collected Researches"; a similar discussion of the horizontal force curves is in progress. Much attention is also being given to the improvement of methods of meteorological observation.

The new observatory at Eskdalemuir was occupied in May, 1908, and the work of installing apparatus was at once commenced. Regular meteorological observations are now proceeding, and the seismographs have been running since September, but the magnetographs have not yet been erected. The delay has been due chiefly to difficulties with damp in the magnetograph houses, which, however, it is hoped are now finally overcome. Absolute magnetic observations have been made three times weekly since October.

The past year has been marked by steady and continuous progress in all branches of the work of the laboratory rather than by any new development of first-rate importance. The construction of the experimental tank will add to the laboratory a new department of special interest, and it is to be hoped that in the near future means may be found of providing the much-needed extensions of existing departments.

THE AËRO AND MOTOR-BOAT EXHIBITION.

THIS exhibition, which opened at Olympia on March 19 and will close on March 27, is the first of its kind to be held in this country. The exhibition has been organised by the Society of Motor Manufacturers and Traders, Ltd., of which Mr. E. Manville is president, and is under the management of Mr. H. A. Blackie. The society has had the cooperation of the Aëro Club, and has succeeded in presenting a valuable collection of models of aëroplanes, several full-sized complete machines, together with ordinary and dirigible balloons, and motor-boats.

Probably the most striking object in the hall is the inflated Wellman dirigible *America*. This airship, in which Mr. Wellman proposes again to attempt to reach the North Pole this year, is about 184 feet long, 52 feet in diameter, and about 70 feet from the top of the envelope to the bottom of the basket. The ship is suspended from the roof of the hall, and has a capacity of 300,000 cubic feet. The car is 125 feet long, the base forming a petrol tank of